VOLUME XXXI NUMBER 4 WHOLE NUMBER 263

THE JOURNAL
OF
THE ROYAL ASTRONOMICAL SOCIETY OF CANADA

DEVOTED TO THE ADVANCEMENT OF ASTRONOMY AND ALLIED SCIENCES

EDITOR
C. A. CHANT
David Dunlap Observatory
Richmond Hill P.O., Ont.

ASSOCIATE EDITORS
R. MELDRUM STEWART
Dominion Astronomer
Ottawa

W. E. HARPER
Director of the Dominion Astrophysical Observatory
Victoria, B.C.

J. PATTERSON
Controller of the Meteorological Service of Canada, Toronto

PUBLISHED MONTHLY
(*Ten numbers per year*)

April, 1937

PRINTED FOR THE SOCIETY
TORONTO: 198 COLLEGE ST.

THE JOURNAL
OF
THE ROYAL ASTRONOMICAL SOCIETY OF CANADA

VOL. XXXI, No. 4 | APRIL, 1937 | WHOLE No. 263

Articles PAGE

The Story of a Great Eclipse ..... *Isabel M. Lewis* 153

Telescope Mountings for Amateur Builders (Conclusion) ..... *H. Boyd Brydon* 156

Radio Talks over CFCT, Victoria, B.C.: 83, The Crust of the Earth; 84, Gifts to Astronomical Science; 85, The Sunspot Cycle ..... *W. E. Harper* 172

Meteor News

Accuracy of Visual Magnitude Estimates—Telescopic Meteor Observations in Japan—Programme of Telescopic Meteor Observations for July-August, 1937 ..... *P.M.M.* 181

Review of Publications

Prévision du Temps par l'Analyse des Cartes Météorologiques, by Jacques van Mieghem (*A. Thomson*); Amateur Telescope Making—Advanced, edited by Albert G. Ingalls (*F.S.H.*) 184

Notes and Queries

Astronomical Summer Courses on the Pacific Coast (*J.A.P.*)—Faint Proper Motion Star—Ursigrams from W1XAL—Wilk Comet (1937c) ..... *F.S.H.* 187

Meetings of the Society

At Toronto—At Winnipeg—At Vancouver 189

Upon request, made previous to publication of article, contributors will be supplied free with fifty copies of the sheets containing the article attached to a printed cover.

If separate reprints are desired the cost will be as follows:

	4 pp.	8 pp.	12 pp.	16 pp.	20 pp.	24 pp.
50 copies....	$3 50	$5 50	$9 50	$10 00	$13 00	$16 00
100 copies....	4 00	7 00	10 00	11 00	14 00	18 00
200 copies....	4 50	8 00	11 00	12 00	15 50	20 00

Covers, extra, 50 copies, $1.50; 100 copies, $2.00; 200 copies, $2.50.

Business correspondence, remittances, etc., should be addressed to J. H. Horning, Treasurer of the Society, 198 College Street, Toronto.

Communications regarding Library matters should be addressed to the Librarian.

$2.00 per annum. Single numbers, 25 cents.

Subscription to the JOURNAL is included in membership fee.

Amateur Telescope Makers will be glad to know that a stock of supplies and accessories including speculum kits, abrasives, plate glass and pyrex blanks, crown flint glass discs, eye pieces, prisms, special brass tubing, cells, cell caps, tripods (complete or castings), mounts to take up to twenty-inch reflectors, slow motions and complete Newtonian and Cassegrain telescopes up to 8" is now on hand in Toronto. R. H. Combs at 46 Lauder Ave. now represents the Tinsley Laboratories of Berkeley, Calif., and also has been appointed special Agent for the distribution of the publications of the University of Chicago Press, which includes the moving picture films made by the Mc.Math-Hulburt Observatory of Pontiac, Mich., of The Moon, Jupiter and its Satellites, Eclipses of the Sun, etc.

THE JOURNAL
OF
THE ROYAL ASTRONOMICAL SOCIETY
OF CANADA

Vol. XXXI, No. 4 APRIL, 1937 Whole No. 263

THE STORY OF A GREAT ECLIPSE*

By Isabel M. Lewis

THE total eclipse of the sun that will occur on the eighth of next June will be one of the great eclipses of history. The duration of the total phase in latitude 9° 54′ N. and longitude 130° 27′ W., where mid-totality will occur with the sun and moon on the meridian and only 13° north of the zenith will be 7^m 4^s which is within 26 seconds of the longest duration that any eclipse can attain. It will be, moreover, the greatest that has occurred in over a thousand years.

Eclipses, as one may verify for himself if he has access to Oppolzer's Canon der Finsternisse, run in series in which each successive eclipse is separated from the one preceding and following it by an interval of 18 years 10 or 11 days known as the eclipse Saros. A series will usually take about 13 centuries to run its course. The first eclipse of the series will be a small partial at the south pole if the eclipses are occurring at the descending node of the moon's orbit, and at the north pole if at the ascending node. Each successive eclipse will be a little greater in magnitude than the one before it and a little farther on the earth. After a few centuries have passed the first total eclipse of the series will appear when the axis of the moon's shadow-cone first touches the earth. A long series of total eclipses will follow, each a little longer in duration than the one that occurred 18 years before and a little nearer to the equator. The great eclipses of the series, the ones with greatest duration of the total phase, will appear in equatorial regions and they will be the three or four preceding the central

*Reprinted from the February number of *Amateur Astronomy*, by permission of the author.

eclipse of the series if the eclipses are moving northward, and the three or four following the central eclipse if the series is moving southward. The central eclipse is the one that occurs when sun and moon are nearest to the node of the moon's orbit at time of conjunction. It will occur generally more than six centuries after the appearance of the first eclipse of the series. After the passing of the central eclipse the following eclipses will occur farther from the node at each return. They are now in the hemisphere opposite to that in which the first eclipse of the series appeared and are becoming gradually smaller and closer to the pole and shorter in duration. Finally, about six centuries after the first total eclipse occurred, the last one will appear in the neighbourhood of the opposite pole of the earth. It will be followed by a number of partial solar eclipses decreasing in magnitude and drawing nearer to the pole at each return. The series will end with a small partial eclipse at the pole opposite to the one at which the first eclipse of the series appeared. When, after the interval of the Saros, sun and moon are again in conjunction they will be so far from the node of the moon's orbit that the moon's shadow-cone will not touch the earth at all. The series of 13 centuries duration will have ended.

The great series to which belongs the total solar eclipse of June 8, 1937, is now running such a course. The central eclipse of this series will be the eclipse of 2009 July 22. The eclipses of maximum duration will be those of 1937 June 8, 1955 June 20, and 1973 June 30, with durations of 7m. 4s., 7m. 6s. and 7m. 5s. respectively. The first eclipse of the series appeared as a small partial at the south pole on June 14, 1360. It was followed by seven partial, four annular and seven total-annular eclipses, that is, eclipses in which the phase is annular near the ends of the path and total in the middle. The first total eclipse of the series occurred on January 17, 1703, and the eclipse at midday was in 68° South latitude. The successive eclipses continued to advance northward toward the equator and increase in duration. The great eclipse of May 18, 1901, was the fifth total eclipse of the series. A number of scientific expeditions from different lands awaited its arrival in Sumatra. The U.S. Naval Observatory had two stations in Sumatra and some excellent photographs of the corona were obtained.

Then came the noted eclipse of May 29, 1919, which afforded such an excellent opportunity to test the Einstein prediction that

rays of light were bent from their course by a certain amount upon passing through the sun's gravitational field. The maximum duration of this eclipse at sea was six minutes and 50 seconds.

The coming eclipse of June 8, 1937, will have a path extending nearly one-third of the distance around the earth in equatorial regions of the Pacific with a maximum width of 153 miles. It passes over no land except a few coral atolls of the Ellice and Phoenix groups, and a small strip of land in Peru just before sunset. The only favourable location within the path, on land, is Enderbury Island of the Phoenix group, $2\frac{1}{2}$ miles long and one mile wide, where mid-totality occurs about 7:45 A.M. with the sun 22° above the horizon. The duration of totality will be a little over four minutes. A more barren and inaccessible site one could not imagine. The island is uninhabited and has scanty vegetation and no water, while landing is dangerous and anchorage unsafe.

On Nukufetau, of the Ellice group, the eclipse will occur about 50 minutes after sunrise. The duration will be over three minutes but the sun will be less than 15° high. Nukufetau is a much more attractive site for an expedition than Enderbury. It consists of a group of islets 24 miles in circuit inhabited by friendly natives living in villages with schools, churches and native teachers.

Christmas Island, one of the largest of the coral atolls and an excellent site in every respect, will be barely grazed by the southern limit of the path of total eclipse at the northernmost point. Here the duration will not be over a few seconds.

On the coast of Peru, near Chimbote, and at Huaraz about 100 miles inland, among the mountains, the eclipse will occur about 35 minutes before sunset and the sun will be only about 8° above the horizon. The duration will be over 3 minutes 20 seconds but no astronomical observations of value may be expected with the sun so low.

This practically exhausts all the possibilities of observing this great eclipse on land. We venture to predict, however, that efforts will be made to observe it at sea and to obtain results of scientific value even under unfavourable conditions. A total eclipse of seven minutes duration is too rare a phenomenon to pass over the earth observed by no one.

United States Naval Observatory,
Washington, D.C.

TELESCOPE MOUNTINGS FOR AMATEUR BUILDERS

By H. Boyd Brydon

(*Continued from February issue*)

VI

Setting Up and Adjusting the Telescope

"An equatorial telescope that is in proper adjustment has its polar axis parallel to the earth's axis, its declination axis at right angles to its polar axis and the optical axis of the telescope at right angles to the declination axis. Its circles are so placed that when the optical axis is directed to the intersection of the meridian and the equator, the declination circle will read exactly 0° plus or minus a small quantity due to refraction and the hour circle will read XXIV or XII according to whether the telescope is east or west of the pier".[22]

The programme for checking these adjustments depends both in manner and extent on the way the telescope is to be used. It may be set in a temporary position for one or two evenings only; it may be portable, that is to say it may have a regular position in the open air but be moved indoors when observing is finished or it may be given a permanent mounting either outdoors or in an observatory.

The tests necessary for a permanent mounting will be discussed. Those that are suited to the temporary or portable positions will then be enumerated. The methods selected here for making these adjustments are not new, they are not the only ones that can be used, but it is believed that they will be found simple and adequate for the purpose intended.

After the telescope has been roughly set in place on the levelling and holding down bolts on the pier, the procedure is:

1. Adjust the optical axis of the finder parallel to the optical axis of the telescope.

2. Set the polar axis approximately in correct position. These preliminary adjustments being made, the remaining ones may be

[22]On the adjustment of Equatorial Telescopes, by Sir Howard Grubb, this Journal, vol. 15, p. 368, 1921; vol. 16, p. 15, 1922. This whole article should be carefully read.

proceeded with in such order that each may be completed practically independently of those which follow.

3. See that the optical axis of the telescope is at right angles to the declination axis.

4. See that the declination axis is at right angles to the polar axis.

5. Set the polar axis to the altitude of the pole.

6. Set the polar axis in the meridian.

7. Adjust the zero of the declination circle.

8. Adjust the zero of the hour circle.

1. *Adjust the finder.* This is most conveniently done in daylight. Point the telescope on a small, well defined, distant object. Bring the image to the centre of the field, finally using the highest power eyepiece. To do this more exactly, use a transit eyepiece and set the intersection of its cross hairs exactly in the centre of the field, which may be checked by the intersection remaining on the object when the eyepiece is rotated. Then set the finder so that its cross hairs also intersect the object, or, if without cross hairs, that the object is as nearly as possible in the centre of the finder field.

2. *Set the polar axis approximately in correct position.* Two things must be done (*a*) Set the inclination of the polar axis to the latitude of the place. (*b*) Set the polar axis in the meridian.

(*a*) The latitude of the place must be known at least to within half a degree. This may be obtained from any good map. Then, as the altitude of the pole is equal to the latitude of the place, construct a right angled triangle with base say 10 inches long and perpendicular 10 times the tangent of the latitude (thus, tan 48° = 1.111; make the vertical side 11.11 inches long). Set this triangle base up, with the hypotenuse resting on and in line with the polar axis. Adjust the slope of the polar axis until the base of the triangle is horizontal as tested with a level. Reverse the level, it may not be true. The polar axis is then approximately at the right inclination.

(*b*) To set the polar axis approximately in the meridian use the following method due to Capt. M. A. Ainslee, R.N. Using a fairly high power eyepiece set the telescope on a star and bring it to the centre of the field. The clock need not be running. In

order to keep the star in the centre of the field, in addition to moving the telescope in right ascension, it will be found necessary to correct the declination from time to time. Note whether the declination is changed to the north or to the south. If the change in declination is of the same name as the latitude (that is, to the north in north latitudes and to the south in south latitudes) the upper end of the polar axis is too far to the westward; if of opposite name the upper end of the polar axis is too far to the eastward. Shift the polar axis in azimuth as indicated by the test and try again. One or two trials, marking the position of the polar axis on the pier for reference, will serve to set the polar axis approximately in the meridian[23].

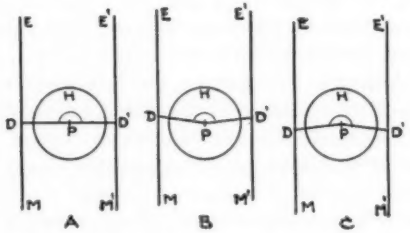


Fig. 22. Checking Optical Axis and Declination Axis.

3. *See that the optical axis of the telescope is at right angles to the declination axis.* We follow Grubb's method, *loc. cit.*

Assume in Fig. 22, A that we look from the direction of the pole down the polar axis of which P is the upper end. Let H be the hour circle (in the plane of the paper) PD the declination axis, EM the telescope, placed east of the pier, M being its mirror.

Let the angle EDP, between the optical axis and the declination axis, be a right angle. That is, this adjustment is correct. Having observed a star in the centre of the field with the telescope east of the pier, when it is turned to the west side of the pier and the star again observed in the centre of the field, the new direction $E'M'$ of the telescope must be parallel to its original direction EM

[23]It will be well worth while for beginners to consider the reason for this rule, it will clear up many things.

since the rays of light from the star are parallel. But, since the angle EDP is a right angle, $E'D'P$ is also a right angle and, since $E'M'$ is parallel to EM, DD' is a straight line and the angle DPD' through which the polar axis has been turned is 180°.

Now consider Fig. 22, B. Let the angle EDP be greater than a right angle. In other words let the telescope be "toeing out". As before, the star is observed first with the telescope east and then west of the pier and $E'M'$ is again parallel to EM, but the angle DPD' through which the polar axis has been turned is now less than 180°.

Similarly in Fig. 22, C, where the telescope "toes in", the angle DPD' is greater than 180°.

But the angle DPD' is the difference in time as shown by the hour circle readings for the two positions of the telescope. Hence in A the difference will be 12 hours, in B, less than 12 hours and in C, greater. So much for the principle of the test, now for the method. To quote Grubb: "Observe a star near the meridian and the equator, the telescope being E of the pier and the driving clock going. At any certain minute by the watch (civil time will serve) stop or disconnect the driving clock and read the hour circle. Call this reading A. Repeat with telescope W of pier and stopping the clock at another certain minute by the watch, again read the hour circle. Call this reading B. If the difference between readings A and B, plus or minus 12-hrs. be equal to the difference in the times of observation as shown by the watch, the telescope is at right angles to the declination axis." Assume however that the readings are:

	Time by Watch			R.A. Circle		
	h.	m.	s.	h.	m.	s.
Star observed E. of pier.....	8	05	00	3	07	16
" " W. " "	8	10	00	15	12	45
Differences.....		5	00		5	29

Evidently the telescope has been turned through a greater angle than 180° and must be "toeing in". This can be corrected by placing a shim under the upper end of the cradle. "If L be the length of cradle in inches, S the error in seconds of time, then the

thickness T, of the shim required will be:

$$T = \frac{15\,SL}{206000} \text{ in.}$$

Or in the above example if $L = 10$ in.

$$T = \frac{15 \times 29 \times 10}{206000} = 0.021 \text{ in.}$$

The object of observing a star on the meridian and the equator is to render this adjustment independent of those that follow."

4. *See that the declination axis is at right angles to the polar axis.* Except that a polar star is observed, the procedure is the same as in the previous test. As the axis of the telescope is now approximately at right angles to its previous position, any small error remaining after the third adjustment cannot appreciably affect this one.

An approximate method which can be used in daylight is the following: With telescope E of pier, by means of a good level set the declination axis housing horizontal and read the hour circle. Pass the telescope to the west side of the pier, set the declination axis housing horizontal and again read the hour circle. The readings should differ by exactly 12 hours. This method is most useful in latitudes above 45°. Two assumptions are involved: (1) That the declination axis housing is cylindrical where the level is placed on it; (2) that the declination axis coincides with the axis of the housing.

Unless special provision is made in the design it is very difficult to correct an error here. Every care should be taken during construction to insure its correctness. A fairly satisfactory way of providing for adjustment of this angle in a pipe mounting is as follows:

After the polar axis has been screwed into place in the outlet of the tee carrying the declination housing, the threads are reamed from the two ends of the run. The housing is then passed through the run of the tee and secured in place with four round pointed set screws at each end of the tee. When by this test the declination axis has been adjusted to a right angle with the polar axis by means of the set screws pressing against the housing, the clearance between

the housing and the tee is filled with neat cement grout or melted sulphur.

The principal parts now being in correct relationship with one another, the remaining adjustments serve to set the instrument itself correctly in place.

A simple method due to Gerrish[24] enables the first two of these, the inclination of the polar axis and setting it in the meridian to be completed at the same time. The method is based on the following considerations:

The position of Polaris is R.A. 1 h. 39.2 m., Decl. 88° 57′.5. Thus the star circles the celestial pole at a distance of 1° 2′.5. Its position on the circle depends on its hour angle. When sidereal time is the same as the star's right ascension, Polaris is at its upper culmination, directly above the pole. Six hours later when its hour angle is six hours west, the star is due west of the pole and so on, its hour angle

t = sidereal time − right ascension

east when t is negative, west when t is positive.

The sine of 1° 2′.5 being 0.0182, if a diaphragm having a circular opening of radius 0.019 times the focal length of the telescope and having its circumference divided into 24 equal arcs be placed centrally over the mirror, when the telescope is pointed at the apparent pole (that is, at the pole as raised by refraction) Polaris will appear to travel westwards round the opening just inside the edge, its hour angle being indicated by the graduations on the circumference.

Preparations for the observations can be made in daylight. Make the diaphragm, mark or perforate the graduations so that they can be easily identified under low illumination, placing the north and west points (t = 0 hr. and 6 hr.) as they will appear when viewed from the eyepiece of the telescope during the observations.

Loosen the nuts on the holding-down bolts so that the mounting can be tilted towards the north or south as necessary to bring the polar axis to the correct inclination. Arrange two bolts, preferably with fine threads, which when turned will push against a suitable projection and turn the mounting in azimuth one way or the other

[24]Gerrish, "The Pole Finder", *Pop. Ast.*, vol. 29, p. 283.

on the holding-down bolts as required by the observations. These azimuth adjusting bolts will be found most useful for it is practically impossible to move such heavy weights accurately by hand alone. A little oil on the sliding surfaces also helps wonderfully.

Centre the diaphragm on the mirror with the north and west points properly oriented and secure it there. With the aid of a fine plumb line carefully place the telescope vertically over and parallel to the polar axis; clamp firmly in both co-ordinates.

Select an eyepiece having an eyeplate with an aperture not more than 2 mm. in diameter, and place in the draw tube slightly inside the focus.

Now, leaving the telescope firmly clamped, move the mounting on the pier until Polaris is seen in the ring of sky between the diagonal and the edge of the diaphragm. Then adjust the mounting in altitude and azimuth until the star is just inside the ring and at the point on the circumference corresponding to its hour angle. Make one adjustment at a time, remembering that a change in azimuth will result in the greatest movement of the star to or from the centre when the hour angle is 6 hr. and in altitude when at upper or lower culmination. Continue to observe, improving the adjustment by slight touches in one or other co-ordinate until the star remains at the same distance from the edge of the opening for several hours. When satisfied of this, the polar axis will be sufficiently accurately set both in inclination and in azimuth for all practical purposes, completing adjustments 5 and 6.

The pointers for the declination circle can now be set so that they both read 90° and adjustment no. 7 is completed.

The final adjustment, of the zero of the hour circle, will be made by the method of Schaeberle[25] as the work can be done in daylight.

Across the top and bottom of the telescope tube fix firmly two metal straps, approximately parallel to one another and projecting several inches from the tube away from the pier and clear of the eyepiece holder. To the outer end of each attach a thin plate having a 1/16-in. hole in it. Through these holes pass a fine line making it fast above the upper hole. Attach a plumb-bob below

[25] *A. N.*, 2374. See also Campbell's "Practical Astronomy", p. 215.

the lower hole. Let the plumb-bob swing in a pail of water to steady it.

Point the telescope approximately to the zenith and adjust the straps until the plumb-line swings nearly free, and tighten the straps firmly in place. Move the telescope by the slow motions until the plumb-line swings clear in the centre of the lower hole. Read both circles.

Unclamp the telescope, hold the plumb-bob in the hand to prevent the line being broken or a strap moved, and pass the telescope to the other side of the pier. Clamp and adjust by the slow motions until the line again swings clear in the centre of the lower hole. Read both circles. It is advisable to take several sets of readings and use the means in completing the adjustment.

The condition for correctness in this adjustment, is that when the telescope is on the meridian, the hour circle must read exactly 24 hr. when east of the pier and 12 hr. when west. An example will show the procedure. The hour circle was divided into 2-min. intervals. In making the readings tenths of a division were estimated. The means of four sets of readings were:

Telescope E	Telescope W
23h 32.8m	12h 28.4m

Adding 12 hr. to the west readings the mean of these averages for both sides was 24h 1.2m. Since the correct reading is exactly 12 hr. or 24 hr. when the telescope is on the meridian, the hour circle was reading 1.2m too high. That is, the pointer was east of its proper place by that amount. To correct the error the hour circle was carefully set to the mean reading, 24h 1.2m, and the pointer then moved 1.2m to the west.

Having finished this adjustment, the whole series should be repeated to check the work. It is a tedious job but the satisfaction and convenience of having one's telescope in correct adjustment is well worth the trouble.

Latitude. If the correction for refraction was not applied when setting the declination circle on the pole in adjustment no. 7, the readings of the circle taken during the last test will be in error by that quantity. For latitudes above 45° this correction is less than 1′ and cannot be found on the circle as usually graduated to one half or one degree for finding purposes.

Keeping this in mind, the mean of the east and west readings of the declination circle is the declination when the telescope is pointed to the zenith. But this is the same as the latitude of the place which is thus obtained within the limits of accuracy of the observations. As a check it is useful to compare this value with the latitude as obtained from a good map.

Conversely, if the latitude of the place is known closer than is here assumed, the declination circle readings should be used to set the polar axis to the proper inclination. The mean of the readings is the present (incorrect) inclination. The difference between this mean reading and the true latitude is the inclination error. Change the last declination circle reading by this amount by moving the telescope in declination in the proper direction, then adjust the inclination of the polar axis until the plumb-line again passes centrally through the lower hole.

When from an otherwise excellent site the telescope cannot reach the pole as not infrequently happens it is convenient to use the following methods due to Sir Howard Grubb:

First, to adjust the zero of the declination circle. Choose any easily recognized star close to the meridian and not less than 30° to 40° N. declination. The telescope being E. of the pier set carefully on this star and read the declination circle. Call this reading *A*. Repeat with the telescope W. of the pier. Call this reading *B*. If these are unequal the declination circle has a zero error equal to half their difference. Correct the readings and re-set on the star and repeat until the declination of any star reads the same with the telescope east or west of the pier.

Second, to adjust the inclination of the polar axis. Set the declination circle to the declination of any fairly high star as given in the Nautical Almanac plus the refraction for the altitude which is equal to the co-latitude plus N. declination, the star being near the meridian. Then alter the inclination of the polar axis until the star is in the centre of the field.

Third, to set the polar axis in the meridian: "Choose two stars of about equal declination, preferably high stars, each being not less than 3 hours from the meridian. Set the declination circle to read the proper declination for that star which is west, omitting any correction for refraction. If the star cannot be brought into

the centre of the field with that declination setting, alter the azimuth of the polar axis until it can" by means of the adjusting screws mentioned above and mark the base of the mounting and top of pier. "Now turn to the star at east. Set the declination circle to the proper declination for this star. If it cannot be brought into the centre of the field with that declination setting turn the azimuth screws until the star is in the centre of the field counting the number of turns required. Now mark the pier opposite the mark previously made on the mounting and turn the mounting back by half the number of turns counted. The mark on the mounting should now be exactly between the two marks on the pier and the polar axis should be in the meridian. This adjustment may then be checked by taking the actual readings of the circle for both east and west stars and if about equal altitude the errors in each case, which are due to refraction, should be equal."

The site for the amateur's telescope is usually very much of a compromise. He has to make the best of the space available or that diplomacy and ingenuity can achieve. Thoughtful study of conditions will generally show the most favourable spot. A clear view is desirable from the pole eastward or westward (the east darkens first) round to the south point. Seeing is never good nearer to the horizon than 15 to 20 degrees so that any obstruction no higher than that as seen from the top of the pier will not interfere. An occasional tree or chimney must be put up with but if possible the prevailing winds should blow the smoke from neighbouring chimneys away from the site which should be high rather than low and screened from street and house lights.

Of course the most convenient and satisfactory arrangement is some sort of observing room, however simple, a dome is quite an unnecessary luxury, in which the telescope can be set up permanently, ready for use in a few minutes when opportunity offers. Failing this, a space enclosed by a fence or trellis to protect against the wind adds greatly to one's comfort and if a concrete pad or wood floor some six or eight feet square can be put down, so much the better.

When an equatorially mounted telescope is to be used in a temporary position the useful adjustments are (1) these made before being placed, adjust the finder, set the inclination of the

polar axis, set the zeros and pointers of the circles; and (2) those made when in place, level the stand; with approximate sidereal time, set off the hour angle and declination of an easily visible fairly high star, clamp and swing the mounting in azimuth until the star is in the centre of the finder field.

When the telescope is to be portable as understood here it is necessary to insure that it can be replaced in its correct position without undue delay. This is done most readily by the centre, groove, plane method. Three cast iron pads about 4-in. diameter are set in the concrete or on creosoted wood posts set firmly, flush with the surface of the ground so that the three points of the telescope support will rest centrally on them. One pad has a plane top, no. 2 is countersunk with a 1-in. twist drill and the third, having a groove with a total angle of 90° planed in it, is set so that the groove is in line with the countersink.

If the support is a tripod as is usual with refractors, the legs should be shod with 60° metal points and each leg firmly braced to its neighbours by a stiff metal strap, say 1¼ by ¼-in. iron, having a hole in each end fitting nicely over a turned metal pin set in the leg about half way from the point. If these straps are removable they should be numbered and always placed on the same pins. A shelf with raised edge all around may be supported on these straps and is very convenient.

If, as perhaps is more common for reflectors, a wheeled, wooden support, rectangular in plan, is used, it can be easily adapted for this method of orientation by fitting three screw pins suitably placed which can be screwed down to seat in the foundation pads, taking the weight off the wheels after the instrument has been wheeled into place. A level may be placed on prepared blocks on the support as a check after this is done.

The points of the support being at a fixed distance apart, if the same one is always placed in the same foundation pad, the mounting will always be similarly oriented. The whole series of adjustments described above therefore may be used appropriately for a telescope so installed though the final result will not be as accurate as with a solid pier.

My thanks are due to Messrs. McGraw-Hill Book Company, the *Scientific American* Publishing Company, and *Popular Astron-*

omy for permission to quote from their publications and to Dr. R. K. Young, Dr. J. A. Pearce, Messrs. F. J. Hargreaves, H. A. Reid, Carl Jorgensen, Albert G. Ingalls, J. Teasdale, R. and L. Hopkins, Wilfred Hobday and others for their generous encouragement and advice in preparing this article.

APPENDIX

Pipe and Fittings. The following tables giving standard dimensions of wrought pipe and screwed fittings and flanges will be of use in designing. Outside diameters of fittings depend on the patterns of individual makers and are not available. In general they run from about ½-in. greater than the inside diameter of the pipe for 1-in. to about 1½-in. greater diameter for 6-in. pipe.

WROUGHT PIPE – STANDARD DIMENSIONS

SIZE	EXTERNAL DIAMETER ALL WTS	STANDARD		EXTRA STRONG		DOUBLE EXTRA STRONG	
		Approx. internal diam.	Wt. per Foot	Approx. internal diam.	Wt. per foot	Approx. internal diam.	Wt. per foot
Ins.	ins.	ins.	lbs.	ins.	lbs.	ins.	lbs.
1	1·315	1·049	1·68	0·957	2·17	0·599	3·66
1¼	1·660	1·380	2·27	1·278	3·00	0·896	5·21
1½	1·900	1·810	2·72	1·500	3·63	1·100	6·41
2	2·375	2·087	3·65	1·939	5·02	1·503	9·03
2½	2·875	2·469	5·79	2·323	7·66	1·771	13·70
3	3·500	3·308	7·58	2·900	10·25	2·300	18·58
3½	4·000	3·548	9·11	3·364	12·51	2·728	22·85
4	4·500	4·026	10·79	3·826	14·98	3·152	27·54
4½	5·000	4·508	12·54	4·290	17·61	3·580	32·53
5	5·563	5·047	14·62	4·813	20·78	4·603	38·55
6	6·625	6·065	18·97	5·761	28·57	4·897	53·16

Dimensions of Wrought Pipes.

Lights for circles, etc. A great improvement on the usual hand flashlight for reading the circles, etc., is a flashlight bulb mounted on a head band or cap as is a miner's lamp. The light is thus out of one's eyes and is ready as wanted in examining maps, making notes, etc., and both hands are free. The bulb is supplied from a battery carried in a pocket and is turned on and off by a snap switch.

polar axis, set the zeros and pointers of the circles; and (2) those made when in place, level the stand; with approximate sidereal time, set off the hour angle and declination of an easily visible fairly high star, clamp and swing the mounting in azimuth until the star is in the centre of the finder field.

When the telescope is to be portable as understood here it is necessary to insure that it can be replaced in its correct position without undue delay. This is done most readily by the centre, groove, plane method. Three cast iron pads about 4-in. diameter are set in the concrete or on creosoted wood posts set firmly, flush with the surface of the ground so that the three points of the telescope support will rest centrally on them. One pad has a plane top, no. 2 is countersunk with a 1-in. twist drill and the third, having a groove with a total angle of 90° planed in it, is set so that the groove is in line with the countersink.

If the support is a tripod as is usual with refractors, the legs should be shod with 60° metal points and each leg firmly braced to its neighbours by a stiff metal strap, say 1¼ by ¼-in. iron, having a hole in each end fitting nicely over a turned metal pin set in the leg about half way from the point. If these straps are removable they should be numbered and always placed on the same pins. A shelf with raised edge all around may be supported on these straps and is very convenient.

If, as perhaps is more common for reflectors, a wheeled, wooden support, rectangular in plan, is used, it can be easily adapted for this method of orientation by fitting three screw pins suitably placed which can be screwed down to seat in the foundation pads, taking the weight off the wheels after the instrument has been wheeled into place. A level may be placed on prepared blocks on the support as a check after this is done.

The points of the support being at a fixed distance apart, if the same one is always placed in the same foundation pad, the mounting will always be similarly oriented. The whole series of adjustments described above therefore may be used appropriately for a telescope so installed though the final result will not be as accurate as with a solid pier.

My thanks are due to Messrs. McGraw-Hill Book Company, the *Scientific American* Publishing Company, and *Popular Astron-*

omy for permission to quote from their publications and to Dr. R. K. Young, Dr. J. A. Pearce, Messrs. F. J. Hargreaves, H. A. Reid, Carl Jorgensen, Albert G. Ingalls, J. Teasdale, R. and L. Hopkins, Wilfred Hobday and others for their generous encouragement and advice in preparing this article.

APPENDIX

Pipe and Fittings. The following tables giving standard dimensions of wrought pipe and screwed fittings and flanges will be of use in designing. Outside diameters of fittings depend on the patterns of individual makers and are not available. In general they run from about ½-in. greater than the inside diameter of the pipe for 1-in. to about 1½-in. greater diameter for 6-in. pipe.

WROUGHT PIPE — STANDARD DIMENSIONS

SIZE. Ins.	EXTERNAL DIAMETER ALL WTS. ins.	STANDARD		EXTRA STRONG		DOUBLE EXTRA STRONG	
		Approx. internal diam. ins.	Wt. per Foot lbs.	Approx. internal diam. ins.	Wt. per Foot lbs.	Approx. internal diam. ins.	Wt. per Foot lbs.
1	1·315	1·049	1·68	0·957	2·17	0·599	3·66
1¼	1·660	1·380	2·27	1·278	3·00	0·896	5·21
1½	1·900	1·610	2·72	1·500	3·63	1·100	6·41
2	2·375	2·067	3·65	1·939	5·02	1·503	9·03
2½	2·875	2·469	5·79	2·323	7·66	1·771	13·70
3	3·500	3·308	7·58	2·900	10·25	2·300	18·58
3½	4·000	3·548	9·11	3·364	12·51	2·728	22·85
4	4·500	4·026	10·79	3·826	14·98	3·152	27·54
4½	5·000	4·506	12·54	4·280	17·61	3·580	32·53
5	5·563	5·047	14·62	4·813	20·78	4·603	38·55
6	6·625	6·065	18·97	5·761	28·57	4·897	53·16

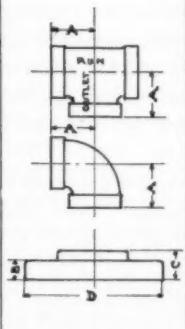
Dimensions of Wrought Pipes.

Lights for circles, etc. A great improvement on the usual hand flashlight for reading the circles, etc., is a flashlight bulb mounted on a head band or cap as is a miner's lamp. The light is thus out of one's eyes and is ready as wanted in examining maps, making notes, etc., and both hands are free. The bulb is supplied from a battery carried in a pocket and is turned on and off by a snap switch.

The lamp holder and reflector from an ordinary flashlight can be easily adapted for such use, a wooden plug being inserted in the flashlight tube to hold the battery cells in place. A No. 6 brass machine screw through the centre of the plug forms the central contact and the terminal for one of the leads to the lamp holder. The lens is not needed. The connections made should utilize the original switch. Details depend upon the construction of the flashlight.

SCRD. TEES & ELBOWS

SIZE. ins.	STAND'D Malleable or Cast Iron A ins.	EXTRA HEAVY Malleable or Cast Iron A ins.
1	$1\frac{7}{16}$	2
$1\frac{1}{4}$	$1\frac{3}{4}$	$2\frac{1}{4}$
$1\frac{1}{2}$	$1\frac{15}{16}$	$2\frac{1}{2}$
2	$2\frac{1}{4}$	3*
$2\frac{1}{2}$	$2\frac{5}{16}$	$3\frac{1}{2}$
3	$3\frac{1}{16}$	$4\frac{1}{16}$
$3\frac{1}{2}$	$3\frac{7}{16}$	$4\frac{5}{8}$
4	$3\frac{3}{4}$	$5\frac{1}{8}$
$4\frac{1}{2}$	$4\frac{1}{16}$	$5\frac{1}{2}$
5	$4\frac{7}{16}$	$6\frac{1}{4}$
6	$5\frac{1}{16}$	$7\frac{1}{4}$



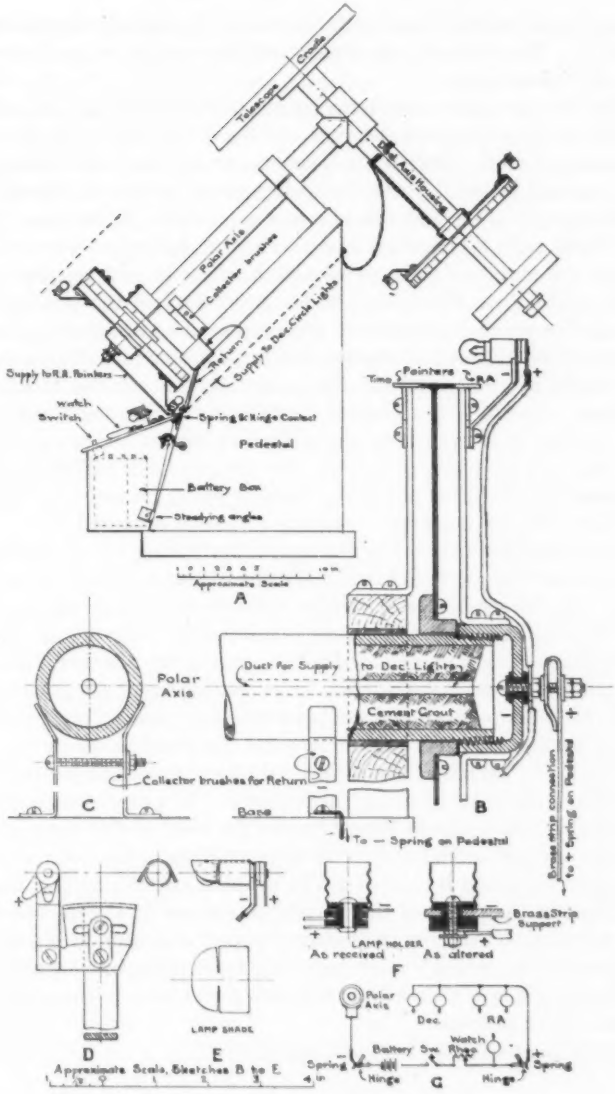
STANDARD FLANGES

	inches	
D	B	C
4	$\frac{7}{16}$	$\frac{11}{16}$
$4\frac{1}{2}$	$\frac{1}{2}$	$\frac{3}{4}$
5	$\frac{9}{16}$	$\frac{7}{8}$
6	$\frac{5}{8}$	1
7	$\frac{11}{16}$	$1\frac{1}{16}$
$7\frac{1}{2}$	$\frac{3}{4}$	$1\frac{1}{8}$
$8\frac{1}{2}$	$\frac{13}{16}$	$1\frac{3}{16}$
9	$\frac{15}{16}$	$1\frac{3}{16}$
$9\frac{1}{4}$	$\frac{15}{16}$	$1\frac{1}{4}$
10	$\frac{15}{16}$	$1\frac{5}{16}$
11	1	$1\frac{7}{16}$

EXTRA HEAVY MALLEABLE SCREWED FITTINGS HAVE THE SAME CENTRE TO END DIMENSIONS AS STANDARD SCREWED FITTINGS.
* ON 2-IN ELBOWS THIS DIMENSION IS $3\frac{1}{4}$ IN.

Dimensions of Pipe Fittings.

Where the mounting can be adequately protected from the weather when not in use, it will generally be found most satisfactory to fit individual lights to the circle pointers. Flashlight bulbs, 3.8-volt or 6-volt, serve admirably. A single wire system can be used, the lights being connected in parallel to a rubber insulated supply lead, the metal of the mounting itself forming the return to the battery which may be three or four No. 6 dry cells. Suitable lamp holders can be obtained at most radio repair shops for 10 or 15 cents. They take up little room and are easily connected in place. The centre one of the three lugs on these holders is not an electrical connection and can be discarded. A 5- or 10-ohm rheostat



Wiring Diagram for Telescope Lights.

in the circuit will be found useful to control the light to the minimum needed. The sidereal time watch and the cross-wires of the finder can be lighted also.

The sketches give some details of the manner in which lights were fitted for a mounting of the type in Figs. 5 and 6.[26] A single wire system was used. Sketch A is a general arrangement, slow motions, etc., are not shown. Instead of being placed inside the pedestal as probably would be desirable in a new mounting, the battery, three No. 6 dry cells, is contained in a wooden box having a hinged lid on which are mounted the control switch, rheostat and sidereal time watch. The box is attached to the south face of the pedestal by two hooks which engage screw eyes so placed as to force the backs of the brass hinges against two flat brass springs on the pedestal. The ends of the wiring on the mounting are attached to these springs. Sketch C is a general diagram of these connections. As the battery leads are connected to the two hinges, the act of securing the box in place completes the electrical connections, while without disconnecting any wires it can be easily removed for taking indoors with the telescope. A strap handle is provided.

The connection between the stationary wiring on the pedestal and the moving circle lights is made, see sketches B and D, as follows. The lamp holder is sweated onto its brass strip support by its negative terminal which thus is grounded to the metal of the mounting. A rubber insulated wire connects the positive terminal to a well-insulated brass machine screw in the end of the polar axis. A flat brass strip, taped and shellaced for protection against possible short circuits, connects this screw with the positive spring on the pedestal. In sketch A the supply lead for the declination pointer lights is shown taken through the pedestal. In a new mounting the end of this lead would be secured under the head of this same screw and run through a duct cast in the cement filling of the polar axis as indicated in sketch B. It would be brought out through an insulated hole in the outlet of the tee and be secured to the declination axis housing, so avoiding the hanging loop of wire seen in sketch A. The return connection is made by spring brass strips bearing against the polar axis as in sketch C from which a wire runs to the negative spring on the pedestal.

[26]This Journal, Vol. 30, 1936, Dec., pp. 387, 390.

To prevent dazzle the lights are fitted with shades shaped as in sketch E, made of thin tinplate and sprung onto the lamp holder.

In using these lamp holders it is often convenient, as in the case of the lamp lighting the sidereal time watch in sketch A, to replace the rivet forming the centre or positive contact by a No. 4 brass machine screw. As this screw not only forms the positive terminal of the holder but also secures it to the brass strip which carries it and forms the negative connection, see sketch F, it must be carefully insulated by fibre washers and a wrapping of friction tape, the whole being given a coat of shellac when put together.

In electrical work of this kind especial care must be taken that good insulation is used. Ordinary "double cotton covered annunciator wire" is not suitable. The insulation must be protected from chafing in service and all connections made readily accessible for replacement or repair.

Victoria, B.C.

RADIO TALKS OVER CFCT, VICTORIA, B.C.

By W. E. Harper

No. 83.—THE CRUST OF THE EARTH

(April 16, 1935)

My last talk had to do with the atmosphere above us; the present one deals with the solid earth beneath our feet. I am going to try to give an idea of its constituents and the possible changes that are taking place in it.

We find the earth's surface mostly covered with water, there being only about twenty-five per cent. of it land. We speak of it as land in the general sense, without distinguishing between soil and rock. While our childhood ideas were that there was a vast difference between soil and rock, we come gradually to see that there isn't much difference after all. The action of the elements such as wind, rain and frost will wear down even the hardest rocks, if given time enough, while many of the sandstones crumble very easily. The differing classes of soil, such as sand or clay are simply the result of the difference in the rocks which gave rise to them, while the black humus is decayed vegetable matter.

The depth of the soil proper is, of course, exceedingly small. Places there are where it amounts to hundreds of feet, but such are more than counterbalanced by extensive rocky areas totally devoid of covering, so that if the soil were spread uniformly over the earth's surface there would be a layer only skin deep.

Below this layer we have the continental rocks and below them we have reason to believe we have rocks of higher density still. It would seem, then, that there is a definite stratification of the materials at the earth's surface. First the atmosphere above us, then the waters resting in lakes upon the rocks or the covering of soil, then the continental rocks, averaging a density about 2.7 times that of water. Below these and the ocean depths we have evidence of rocks of higher density.

When we think of the suggested origin of the earth, namely that it has been thrown off from the sun while in a plastic if not gaseous condition, it is only reasonable to believe that the heavier elements would sink to the centre. Thus the lighter elements would filter up to the top and give us the lighter rock mantle, surmounted again by the atmosphere itself.

The lighter rocks are known by the general name of granites, while the heavier ones, about 11% denser, are called basalts. Now in many parts of the world this heavy basalt is found to cover vast areas of many thousands of square miles. How has it got there, since its logical home is miles beneath the continental structure of the granites? There seems no alternative to the theory that the earth's interior has been at such a high temperature that these have melted and in the fluid state have been squeezed up out of cracks or openings in the earth. The molten mass has then spread out to great distances before solidifying.

Examples of these outflows might be cited. The best known one is the Giant's Causeway in Northern Ireland, of which we have all seen pictures at least. Then there are what are known as the Deecan Traps, covering 200,000 square miles of the north-west of the peninsula of India, which is overlaid to an average depth of half a mile. In the Columbia River district outflows of these basalts cover 250,000 square miles and similar large areas cover Argentine, Brazil and even as far south as Patagonia.

These outflows have not been confined to any one particular period in the earth's history, but have featured all geological eras from the earliest to the present. Moreover, all over the earth these lavas are strikingly alike in chemical composition. The density is uniformly 3.0, i.e., a volume of basaltic material has three times the mass of a similar volume of water. Such facts strongly support the view that these outflows come from a common reservoir underlying both oceans and continents.

The ocean floor may be considered as the upper surface of this substratum and there has, undoubtedly, been vast quantities of this basaltic lava poured on the ocean floor through fissures in its upper surface. Indeed many of the islands are almost wholly basaltic in character with the same density and general character as the outflows covering the land. This is added proof of a common reservoir deep down in the earth.

I have stated that such flows have occurred in every age. Such a statement taken literally would give a wrong impression as within historical times I doubt if any such large-scale outpourings have been recorded. What was meant was that from time to time during

the millions of years of the earth's history such flows occurred whose approximate dates can be read by the geologist from the rocks themselves. At present, though, the substratum seems solid and the query comes to us: Will it ever become liquid again and when?

It will. The earth's interior is gradually heating up and in due time further outflows will occur. We need not get in a panic, though, for it will not be in our day. Hundreds of thousands of years will elapse before the substratum will have reached the temperature of liquefaction.

What is the source of internal heat? It is a recent discovery being no older than the discovery of X-rays. All rocks, granites or basalts, are radioactive, that is, the heavier atoms constituting them, like uranium and thorium, are continually disintegrating, which disintegration is accompanied by the production of heat. Such action is automatic; it does not seem possible to hasten nor retard it.

Uranium, the heaviest element, with atomic weight 238, changes eventually into lead with atomic weight 207. It might be thought that in the millions of years postulated for the earth's existence, that it all would by now have been so transformed. Its rate of decay is so slow, however, that one-half of the present supply will not have disappeared for another 5000 million years.

The amount of heat produced by the radioactive process is to our earthly ideas infinitesimal. It would require a period of about 10^7 years for the process to effect a change of one degree in temperature. While the temperature of liquefaction of basalt is 1150°C. it would not be a case of heating the rock up to this temperature from zero. When the congealing has taken place the temperature has, of course, dropped, but one can imagine that the difference in temperature between solid and liquid states need not be excessive. If it were as much as 10° then it would require 10×10^7 or one hundred million years to change from one state to the other. During the earth's lifetime it has been estimated that at least five such great changes have taken place.

No. 84.—GIFTS TO ASTRONOMICAL SCIENCE

(June 18, 1935)

Returning from a somewhat hurried trip to Eastern Canada where I witnessed and took some small part in the dedication of a great observatory to astronomical work, it has occurred to me that my seven minutes this evening might be used in recalling some of the great gifts to our science that have been made in the past.

I shall go back no farther than sixty years ago, when a rather eccentric old bachelor who had amassed a fortune in the organ and piano manufacturing business in San Francisco, executed a deed of trust conveying his entire fortune of about $3,000,000, to public purposes. Included in this was the sum of about $700,000 to be expended for a powerful telescope, superior to any then in existence, and with it a suitable observatory. Any unexpended balance was to serve as a partial endowment.

The result was the establishment upon Mount Hamilton, about eighty-three miles from San Francisco, of a great observatory which has for over half a century been giving us new ideas of the great universe in which we live. The lens of the main telescope is 36 inches in diameter and subsidiary instruments round out the astronomical equipment of this great mountain observatory. Chief among the results of their work has been the determination of the velocities of the stars in the line of sight. The stars are not fixed in space as it was at one time thought, but are moving at random hither and thither, some approaching, some receding. This mountain observatory is recognized as a leader in this work, which later was taken up at similar institutions like our own at Victoria. At present the total number of stars whose velocities are known is about 7,000. In one region of the sky the velocities are preponderatingly those of approach, whilst in the diametrically opposite region the stars are, on the average, receding from us. The explanation is that our own star, the sun, carrying its family of planets along, is itself moving in the direction from which the stars seem to be approaching. Its speed in this journey through space is about 12 miles per second.

The next great observatory founded upon the gift of a wealthy

individual is the Yerkes Observatory near Chicago. Charles T. Yerkes offered to give monies to the University of Chicago to enable them to secure a telescope superior even to the Lick. In the language of the street, it had to "lick the Lick". This was about the time of the first World's Fair at Chicago in 1893, where was exhibited two huge disks of glass, later to become the 40-inch lens of the Yerkes telescope. Like its twin sister on the Pacific slope, it studied the velocities of the stars but perhaps it and the Bruce telescope, named after the donor, Miss Bruce, are better known by its discovery of obscuring clouds in space. Photographs of the starry skies show regions almost devoid of faint stars, whilst nearby regions are simply "plastered" with the little points of light. At first it was thought that such dark regions were in reality regions devoid of stars, but on reflection it was hardly considered possible that such vacancies could extend clear through the total depth of the stars. Barnard of the Yerkes Observatory held to the idea that these dark regions were caused by clouds of gas or finely divided matter lying between ourselves and the fainter stars and thus occulting or blotting them out from view. His view is now generally accepted and the acceptance of it was the beginning of several more general investigations which resulted in diminishing, by at least 25 per cent., our ideas of the scale of the universe. Street lights seen through fog, you know, seem farther away than they actually are and the interstellar matter pervading all space, even though it is so finely divided and tenuous, will by reason of its great extent act like a fog and cut down the light of the distant stars. This is a new conception which has far-reaching consequences and which came to us by reason of the work at the Yerkes Observatory.

Then there is the Lowell Observatory at Flagstaff, Arizona, which was built and partially endowed by Percival Lowell, who amassed a small fortune in the textile trade in Massachusetts. As a graduate of Harvard in honour mathematics, he was always interested in the stars and, while still in his forties with a comfortable fortune secured, he decided to give up business and devote the rest of his life to astronomy. To him we owe much of our knowledge concerning the physical conditions on other planets for he planned this great desert observatory with that type of work in view. While

their telescope is not a large one, it is sufficiently so for such studies, but their wonderful station, 7,300 feet above sea level, with seeing conditions unequalled elsewhere on the globe, enables them to see and photograph surface details that are impossible elsewhere. It is now accepted that Mars has some slight atmosphere with traces of oxygen and water vapour sufficient to sustain some form of life. The past few months have given us new ideas of atmospheres of the outer planets where excessively low temperatures of 100° to 150° below zero Centigrade are the rule and where ammonia and methane gases abound in the atmospheres.

Time fails one to mention all so I shall conclude by a reference to one nearer home. The newest gift to astronomical science is the David Dunlap Observatory just north of Toronto, given by Mrs. Dunlap to the University of Toronto as a memorial to her late husband. It is very much like our own, though the telescope is two inches greater in diameter. The cost all told would probably be in the neighbourhood of $500,000, and certainly no more enduring monument could ever be erected. For generations to come people will point with pride to this institution as an example of how best to perpetuate the memory of a loved one. It will be as a city that is set upon a hill which cannot be hid and as a lamp which giveth light to all the world.

May Mrs. Dunlap's splendid example stimulate other Canadians to devote their wealth to discover Truth for The Truth Shall Make Us Free.

No. 85.—THE SUN SPOT CYCLE

(July 16, 1935)

News despatches in the daily papers refer to dark spots on the sun as having been seen at various places in the world and reported to the press. It might be thought by some that these are something new, but such is not the case. It is true, though, that more are being seen this year than for the past few years, for we have passed through a period of a minimum number and they are now on the increase, reaching their maximum about three years

hence. As the larger ones can be seen with the naked eye, protected of course with a smoked glass or piece of photographic film, it may not be amiss to say a few words about them if only to direct amateur astronomers to their observation.

While there are records in the Chinese annals of a few thousand years ago that would seem to show that they had observed these dark blotches on the sun's surface, it was not until Galileo turned his newly-invented telescope to the sun some three hundred and twenty-five years ago that it could be said they were actually observed. From that time (1610) until about 1645 they were, on the average, probably as numerous as now. But from 1645 to 1715 very few spots were observed although with improved telescopes astronomers were observing the sun. Just why there was this deficiency is not known, but is a fact just the same. From that date to the present the numbers have been pretty much as we find them nowadays.

Sun spots come and go, however, in cycles of about 11¼ years. There was a maximum early in 1906 when I obtained at Ottawa several photographs of exceptionally large disturbances. Maxima occurred again in 1917, in 1928 and as stated, another is due in 1938. This periodicity was discovered by an amateur, Schwabe by name, who for twenty years had kept a continuous record of their number. This discovery in 1843 stimulated interest in solar observing, and since then the daily record of their number is almost complete.

The nature of the disturbances may somewhat loosely be said to approximate that of volcanoes on the solar surface. Matter in an exceedingly finely divided state is projected outwards from these openings in the surface at a very high velocity. This swarm of electrified particles travelling outwards at velocities of a few hundred miles per second may reach as far as the earth, when we will experience dislocation of our telegraphic communications and usually have a display of the aurorae (Northern Lights). The connection between the number of spots on the sun and the frequency of magnetic storms and aurorae on the earth has long been known, but the exact nature of the relation is not as well determined. Ultra violet radiation, more pronounced at sun-spot maximum, undoubtedly has a bearing on the question.

Nor is the cause of the solar cycle itself well understood. Many

attempts have been made to show that it is due to planetary or meteoric influences but the results are unsatisfactory and it seems more probable that the cause is to be found within the sun itself. The sun is a star and within recent years many stars have been found which undergo changes somewhat akin to our own star. The periods in general are shorter but there is no reason to doubt that when sufficient time has elapsed astronomers will have found stars having periods of variability of the order of our own sun and the study of such variable stars will help in the elucidation of our own. It is likely that in some way during the quiet interval at minimum activity an unstable condition may be created by the accumulation of internal solar energy which, when released, is accompanied by the formation of sun-spots.

If you are sufficiently interested to observe the spots with a small telescope or binoculars, be sure to protect your eyes by using some smoked-glass arrangement. Plot a chart showing their position on the sun's disk and you will notice that they shift from day to day. From their appearance at the eastern limb of the sun until they disappear at the western limb about twelve days will be found to have elapsed. Thus you will make the discovery for yourself of the sun's rotation on its axis in about 25 days.

You will notice also that the spots at present on the sun do not cross near the centre, that is to say, they avoid the equatorial region. When a new cycle is beginning, as is the case now, the spots appear in latitudes about 45°, just halfway between the equator and the pole. Thus at present there are likely to be spots about 45° on either side of the equator but as time goes on these regions of disturbance creep closer and closer to the centre. In 1938 at the maximum they will be only about 15° on each side of the equator and when the last ones of the present cycle die out they will have come within about 5° of the central line. This is an observed fact for which there is as yet no explanation.

The spots show a dark central umbra, surrounded by lighter shaded penumbra. They are dark only by contrast with the intense brilliance of the surrounding surface of the sun and if the whole surface unaffected by spots could be masked out, the light emitted by a single spot group, say 50,000 miles in diameter, would illuminate

the earth with a brilliance surpassing the full moon more than a hundred fold.

Not only do the sizes of the spots vary but their duration or life varies also. Some last only a few days, but in general they last for weeks, and one has been known to persist for eighteen months.

I have alluded to a relation between the number of spots and magnetic and auroral disturbances on the earth. We find also that by studying the growth of trees as shown by the size of their annual rings that there is a close relation here also and conversely by obtaining suitable trees of great age and measuring the thickness of these rings we can infer conditions on the sun as far back as the beginning of the Christian era. The one-to-one correspondence has been identified by Douglass of Arizona, who has made a special study of such matters.

The relations between sun-spots and the weather, however, are none too definite and until further exhaustive investigations are completed we should treat lightly articles in the press which infer that a definite relation is an accepted fact. This much we can say, that temperatures on the earth seem to be slightly higher at sun-spot minimum than at maximum, yet since terrestrial temperatures depend on a number of other factors more important than sun-spots, it would be folly for merchants, dealing in ladies' wear, for example, to fail to order their usual supply of summer dresses in the next few years simply because we are reaching a maximum of sun-spot activity.

METEOR NEWS

Observations relating to meteors and meteorites are cordially invited.

The Accuracy of Visual Magnitude Estimates

In the visual programmes of meteor observation conducted during the last few years the observers have been asked to make estimates of the stellar magnitudes of the meteors recorded. This was usually done by comparing the luminosity of the meteor with a standard stellar sequence visible at the same time, magnitudes being recorded to the nearest whole magnitude. Tables of magnitude distributions have been published from time to time in these notes. If these observed magnitude distributions are to be used in statistical investigations the probable error of an individual magnitude estimate should be known. The best way to determine this is to study the interagreement of the magnitude estimates for a meteor seen by several observers. Unfortunately, in most of the programmes referred to above, the magnitude was recorded only on the record sheet so that, for a group of two to six observers, there was just one magnitude estimate for each meteor. Hence the study of the probable errors in the magnitude estimates was necessarily restricted to stations where two or more groups worked together. Commencing with 1936 each observer has recorded his own magnitude estimate and this procedure gives a better indication of the errors involved.

The Leonid observations from 1932 to 1936 and the Perseid observations for 1934 and 1936 contained nearly 800 meteors for each of which there were two or more magnitude estimates made from the same station. The probable error of an individual observation was computed from the average deviation by Peter's approximate formula. The results are tabulated below:—

Probable Error of an Individual Magnitude Estimate

	Meteors with 2 observations	Meteors with 3 or 4 observations	Mean for all meteors
No. of meteors	642	141	
p.e. in mags.	±0.40	±0.49	±0.43

It will be noted that there is a systematic difference between the p.e. computed from two observations of each meteor and that derived from three or more estimates. This difference probably arises because the magnitudes were only given to the nearest integer while the mean probable error is less than half a magnitude. The final mean p.e. was computed by giving the meteors with three or more observations double weight. The mean p.e. for each magnitude, computed in the same way, is given below:—

Mag.	<0	0	1	2	>2
p.e.	0.41	0.50	0.41	0.42	0.43

There appears to be no correlation with magnitude.

The value of the p.e. determined above is for observers who were in general untrained. It is in good agreement with the p.e. ±0.35 mag. determined by Öpik* from the Perseid observations of 1920 and 1921. In this latter case the observers had, on the average, more training than those taking part in the Canadian programmes and magnitudes were estimated to the nearest half magnitude. In the one case where this was not done the p.e. was considerably greater. We may conclude then that the p.e. of a single magnitude estimate is well under half a magnitude even for comparatively untrained observers recording to the nearest whole magnitude.

Telescopic Meteor Observations in Japan

An interesting report of telescopic meteor observations made in Japan has been received from Dr. M. Huruhata of the Tokyo Observatory. This work was carried out in the vicinity of Tokyo at the time of the Perseid shower in 1936. The observed rates are tabulated below.

These observations indicate a maximum Perseid rate of about 15 meteors per hour at Aug. 14.5 G.C.T. and a very nearly constant rate of 2 per hour for Non-Perseids. Dr. Huruhata states that further telescopic observations of meteors are planned for the future.

*Tartu Pub. vol. 25, no. 1, p. 9, 1922; no. 4, p. 9, 1923.

TELESCOPIC OBSERVATIONS OF THE PERSEIDS IN 1936

Observer 1: K. Gomi—15 mm refractor, 6X
2: H. Inouye—26 mm refractor, 5X

Date, 1936	Observing Period J.S.T.	Observer	Meteors P	Meteors NP	Hourly Rates P	Hourly Rates NP	Meteors with Trains
July 29-30	1.10-2.00	2	5	2	6	2	2
Aug. 11-12	11.00-1.00	2	6	2	3	1	4
	0.09-0.35	1	5	0	12	0	
12-13	0.10-1.30	2	10	4	8	3	5
	0.25-1.02	1	8	2	13	3	3
13-14	0.00-0.40	2	9	1	14	2	1
15-16	1.00-1.45	2	7	2	9	3	3
	1.17-1.39	1	6	1	16	3	
16-17	0.09-0.34	1	4	1	10	2	
17-18	0.00-1.50 (less 20 m)	2	10	3	7	2	3
		Totals	70	18			21

A PROGRAMME OF TELESCOPIC METEOR OBSERVATION FOR JULY-AUGUST, 1937

The Japanese observations reported above illustrate the useful work that can be accomplished in making meteor observations with small telescopes. It might not be out of place to mention here some plans for meteor observations to be made this coming summer. A photographic and visual programme for the observation of the Perseids will be carried out as in other years, but, in addition to this, the writer would very much like to see members of the Society take an active part in telescopic meteor observing. Anyone possessing a small telescope or pair of binoculars is elegible for this work and even if only an hour's observation could be carried out during two or three evenings in July and August, the combined results of a number of observers would make a very valuable addition to our knowledge of telescopic meteors. The writer will be glad to get in touch with anyone who has, in addition to the necessary equipment, interest enough to make at least one hour's observation some time during the months of July and August. This work is planned for any night convenient to the observer and will supplement that done on the special nights of the International Programme which was reported in the JOURNAL for February.

P. M. M.

REVIEW OF PUBLICATIONS

Prévision du Temps par L'Analyse des Cartes Météorologiques (*Weather Forecasting by Analysis of Weather Maps*) by Jacques van Mieghem. 138 pages 6½" by 9¾", Paris, Gauthier-Villars & Cie, Price 35 francs.

At Bergen, Norway about twenty years ago Professor V. Bjerknes with his son, now Professor J. Bjerknes, developed a new concept in meteorology that has in succeeding years revolutionized weather forecasting. Although the old notions of the movement of centres of high and low pressure have not been discarded, they are only used by present day forecasters to supplement the application of the more fundamental principles of Bjerknes.

While these principles have been stated with great clearness in "Physikalische Hydrodynamik" and memoirs published by Bjerknes, Petterssen, Refsdal and Bergeron, there has been no inclusive discussion of how these principles may be applied by a practical weather forecaster to the data now available on the weather map. This new book by Jacques van Mieghem helps to meet this demand and makes available the sections of many theoretical papers that are directly useful to a forecaster. If one cannot go to Bergen to study forecasting, this book gives the next best guide to the ideas he would find there. The foreword by J. Bjerknes is a guarantee of the reliability of the contents.

Prévision du Temps is, however not an elementary book and can only be read with profit by those who already possess some knowledge of meteorology. The properties and characteristics of "air masses" and "fronts" are carefully described with valuable hints on how to recognize them on the weather map. Methods are described for utilizing in a forecast the temperature and humidity data obtained by airplanes at high levels in the atmosphere.

The book would be read with profit by physicists who wish to know the latest developments in meteorology and by all university students in this subject.

A. THOMSON.

Amateur Telescope Making—Advanced. Albert G. Ingalls, Editor. pp. vi + 650, 5½ x 7½ ins. New York, Scientific American, 1937, postpaid $3.00.

This book is a valuable addition to the library of anyone interested in the construction of telescopes. It is important to notice that it is *not* merely a new edition of the Scientific American's famous Amateur Telescope Making, but is rather a sequel, or companion volume, which discusses certain of the finer details of the art of telescope making in a more advanced manner.

The book consists of two fundamental divisions. The first five hundred pages deal with problems in construction, while the last hundred and fifty are concerned with some of the problems of observational programmes and observing technique.

This work is enriched by the contributions of many amateur and professional astronomers and telescope makers, both by signed chapters on various subjects, and by extensive or brief quotations from previously published reports, or from letters. The editor, who is widely known for his monthly section for amateur telescope makers in the Scientific American, has done an excellent job of selecting, unifying, and supplementing the work of the many contributors.

While undoubtedly the beginner must still work with Amateur Telescope Making conspicuously before him, all workers will rejoice in the number of new fields opened to them by this advanced volume. Extensive sections on testing of mirrors, on the grinding of small lenses such as for eyepieces, and on making larger achromatic refractor lenses, will furnish information for further optical work. Chapters on design of various mountings, and on the technique of pattern making, of casting and of telescope drives, will undoubtedly be of great aid in improving the general mechanical standards of the thousands of home made telescopes already in existence and those about to be built. Still other constructional problems include the design of Schmidt cameras, precision clocks, micrometers and chronographs.

The observational part of the volume stresses the applications of completed instruments to the problems of astronomical observation and research. The possibility of systematic and productive observations undoubtedly is of great importance for the sustained

interest in telescope making as a hobby. It is to the mutual advantage of telescope makers and astronomers—amateur and professional—that there be close co-operation between the two branches of work.

Readers of the JOURNAL will be interested to note that there are chapters on the 19-inch Reflector, by Professor R. K. Young, and on Meteor Photography, by Dr. P. M. Millman.

The number and excellence of the various contributions in this volume is a measure of the advance the art of telescope making has made in the last few years, and is surely a tribute to the enthusiasm and genius of the editor and of Mr. Russell W. Porter, who have done so much to foster this hobby.

F. S. H.

NOTES AND QUERIES

Communications are invited, especially from amateurs. The Editor will try to secure answers to queries.

Astronomical Summer Courses on the Pacific Coast

Dr. Daniel Buchanan, Dean of the Faculty of Arts and Science, University of British Columbia, will conduct two courses in Astronomy in the Summer Session of the University of California at Los Angeles, June 26 to August 6, 1937, while Dr. Frederick C. Leonard, Chairman of the Department of Astronomy of the University of California at Los Angeles, will teach the astronomical courses in the Summer Session of the University of British Columbia, Vancouver, July 5 to August 20, 1937.

J. A. P.

Faint Proper Motion Star

Dr. W. J. Luyten, of the University of Minnesota, has reported (Harvard Announcement Card 405, February 19, 1937) the discovery of a fourteenth magnitude star of proper motion 3.″27 annually. This motion was detected by Dr. Luyten in his extensive survey of plates taken with the 24-inch Bruce refractor of the Harvard Observatory.

He has measured the parallax of this star from six small scale plates, and finds a preliminary value of 0.″53 ± 0.″20. This corresponds to a distance of only six light years, and if correct, it will place the star among those very nearest to the sun. Further measures of the parallax of this star will be awaited with great interest.

Ursigrams from W1XAL

Scientific American, April, 1937, contains the following account:

Groups of scientists and research workers in all parts of the world will now be able to receive daily radio broadcasts of cosmic data, sun spot changes, and magnetic disturbances via short waves from W1XAL in Boston, Massachusetts. President Walter S. Lemmon (W1XAL) inaugurated the new radio service starting February 1st. At 4:55 p.m., Eastern Standard Time, each weekday, bulletins known as Ursigrams are to be broadcast over W1XAL

on 11.79 megacycles (25.45 meters) and will be picked up by laboratories equipped with radio receivers not only in all parts of the North American continent but also in Europe, South Africa, and Australia as well. Weekly summaries of this data will be given each Monday at 8:30 p.m. on 6.04 megacycles (49.67 meters).

Science Service at Washington is co-operating with W1XAL in this work. They have been compiling this scientific data daily for several years. Previously these bulletins have been mailed to selected lists of research workers and also transmitted in telegraph code from NAA, the naval radio station in Arlington, Virginia, to a limited number of points. Now through the world-wide facilities of W1XAL this broadcast service will enable many thousands of scientific observers and amateur astronomers to receive up-to-the-minute information to assist them in their local observations. Through the co-operation of the Harvard Observatory, reports of any unusual celestial phenomena will also be added to the broadcast.

The name Ursigram is derived from the initials of the Union Radio Scientifique Internationale which formulated the original plan for gathering cosmic data.

WILK COMET (1937 c)

On February 27 a new seventh magnitude comet was discovered by Dr. Wilk, of Cracow, Poland, and the same night independently by Mr. L. C. Peltier, of Delphos, Ohio. Orbits have been computed for this comet at Harvard, Berkeley, Brown, and Michigan. From a three day arc Dr. Maxwell of Michigan, gives the following elements:

Date of Perihelion Passage	T	1937 February 21.85080	
Longitude of Perihelion	ω	32° 07′ 41″	1937.0
Longitude of Ascending node	Ω	56° 50′ 29″	
Inclination of the orbit	i	26° 21′ 51″	
Perihelion distance	q	0.62141624	

The ephemeris computed from these elements gives the position for April 1 as α 4^h 15^m, δ +68°51′; distance of comet from sun 1.005, from earth 0.583 astronomical units. The magnitude then will be about the eighth.

F. S. H.

MEETINGS OF THE SOCIETY

AT TORONTO

February 9, 1937.—The regular meeting of the Toronto Section of the Royal Astronomical Society of Canada was held on the evening of Tuesday, February 9, 1937, in the McLennan Laboratory, University of Toronto, Mr. E. J. A. Kennedy in the chair.

The minutes of the last meeting were adopted as read. Miss Budd read through the new executive for both the society as a whole and the Toronto section.

The assistant librarian reported that she had several copies of the "Monthly Evening Star Map" for free distribution, as well as a few library books for loan.

The paper of the evening was "The Amateur's Contribution to Astronomy", given by Dr. Helen Sawyer Hogg, Research Associate at the David Dunlap Observatory. She defined an amateur astronomer as one who studies the stars for his avocation, and traced the work of several astronomers of historical fame. To-day amateurs organize themselves into societies, some of the more active of these being, The Royal Astronomical Society of Canada, the British Astronomical Association, the American Association of Variable Star Observers, with half a million observations to their credit, the American Meteor Society, the American Telescope Makers Society, and the American Amateur Astronomical Association. The various fields in which the amateur can and has done much valuable work are: (1) telescope making, (2) variable star observing, (3) novae searching, (4) comet searching, (5) meteor programme, (6) meteorite searching, (7) planets, (8) moon, (9) sun, (10) computing, (11) eclipses. Dr. Hogg drew attention to the results of the contemporary amateur Mr. Peltier, a farmer, who with a borrowed instrument has discovered two novae, 3 comets, and made 50,000 variable star observations.

The second paper of the evening was given by Mr. Collins, on his recent trip to Mexico, which took him far enough south to observe Canopus and α Eridani. He visited the Adler Planetarium and the Museum of Natural History in Chicago and showed us several slides of many other interesting points along the way. Mr. Collins also reported Mr. Topping's observations of several changing sunspots on Saturday, January 30.

Mr. Duncalfe again refreshed in our minds the sad state of affairs resulting from our present calendar and stressed the need for calendar reform. The meeting then adjourned.

February 23, 1937.—The regular meeting of the Toronto Section of the Royal Astronomical Society of Canada was held on Tuesday evening, February 23, 1937, in the McLennan Laboratory, University of Toronto, with Mr. J. R. Collins in the chair.

The minutes of the last meeting were read and adopted. The following

Observation Committee, nominated by the committee appointed at the last council meeting of the Toronto Section, was adopted on the motion of Miss R. J. Northcott and Mr. F. L. Harvey:

Observation Committee of the *Toronto Section* of the *R.A.S.C.*:

Section 1. Observations of variable stars and novae, including the novae search programme.
Director: Miss F. S. Patterson, 78 Grosvenor St. Ki 5790.
Advisor: Dr. Helen S. Hogg, Dunlap Obs., Richmond Hill.

Section 2. Observations of meteors, fireballs and meteorites.
Director: Mr. S. C. Brown, 22 King's Lynn. Ju 7464.
Advisor: Dr. P. M. Millman, Dunlap Obs., Richmond Hill.

Section 3. Observations of the surface features of the sun, moon and planets.
Director: Mr. J. R. Collins, 253 Wychwood Ave. Ll 6678.
Advisor: Dr. J. F. Heard, Dunlap Obs., Richmond Hill.

Section 4. Observations of occultations, comets and asteroids.
Director: Mr. D. A. MacRae, 274 Heath St. E. Hy 8514.
Advisor: Dr. F. S. Hogg, Dunlap Obs., Richmond Hill.

The committee will concern itself primarily with observations which are of some value to astronomy and are worth putting on permanent record. Anyone wishing to make observations will register with the director of the section or sections in which he is interested. The director will then plan an observation programme for him and receive monthly reports on progress. These will be reported at the meetings and, if in sufficient numbers, will be published in the JOURNAL. Observations may be made in Sections 1 and 2 without telescope aid. In Sections 3 and 4 some optical aid is an essential.

The following persons were elected to membership in the Toronto Section:
Mr. R. Hackett, 548 Beresford Ave., Toronto 9.
Mr. H. F. Hutcheson, 32 Thome Cres., Toronto 10.
Mr. K. J. Godden, 170 Dowling Ave., Toronto 3.
Mr. V. F. Sirman, 64 Victor Ave., Toronto 6.
Miss V. E. Foster, 18 Eastmount Ave., Toronto.

The paper of the evening, "The Southern Constellations", was given by Mr. S. C. Brown, Vice-Chairman of the Toronto Section. He taught us the more conspicuous constellations of those skies below the equator, and described in detail the more interesting objects. Illustrated by slides, the Magellanic Clouds, Southern Cross, Coal Sack, 47 Tucanae, and the brighter stars, were impressed upon the minds of the listeners.

Mr. Hooper recited for us, a fine poem of considerable length, titled "A Trip to the Stars".

Mr. Collins read the Harvard Cards announcing comets Whipple and Daniel, and reporting a faint star in Aquarius which has a proper motion surpassing all previously known. Attention was drawn to the numerous sun spots visible at the present time. Following a lively discussion on the probability of an expanding universe the meeting adjourned.

March 9, 1937.—The regular meeting of the Toronto Section of the Royal Astronomical Society of Canada was held in the McLennan Laboratory, University of Toronto, Tuesday, March 9, 1937, with Mr. E. J. A. Kennedy in the chair.

The minutes of the last meeting were read and adopted on the motion of Mr. Hooker and Mr. Horning.

Mr. R. B. Laing, M.A., Fenwick, Ontario.
Mr. W. G. Connor, 600 Spadina Ave., Toronto.

were elected to membership.

Miss Budd read a list of the recent periodicals received by the library, and the chairman asked for the recall of all books out on loan, for recataloguing.

Mr. Collins being ill with the flu, registration in the Observing Sections was left over till next week.

The paper of the evening, "The Meaning of Astronomical Terms" was given by Mr. J. H. Horning, M.A. He explained with slides all the terms used in the Handbook, paying especial attention to systems of co-ordinates and their usage, the planetary configurations, time, magnitudes, meteors, distances, and orbits.

Mr. Harvey referred to the current phenomena as published in the Handbook, noting the conjunction of Saturn and the Sun on March 16. The fairly favourable opposition of Mars on May 19, 1937, was also brought to our attention. The meeting then adjourned.

F. Shirley Patterson, *Recorder.*

AT WINNIPEG

February 10, 1937.—Winnipeg Centre held session February 10th in Theatre F; and was addressed by Fr. Chabot of St. Paul's College on Spectroscopic Analysis and its applications in Astronomy. He used a dozen or more slides and excellent prism apparatus to illustrate his lecture. Spectroheliography gave photographs of the sun's surface layers at varying depths according to the predominating gases at those depths. The spectroscope gave rotation details of double stars. The discussion was led by Dr. Warren. Mr. S. T. Cormack was added to the membership. There was an attendance of 36.

G. P. Morse, *Secretary.*

AT VANCOUVER

February 9, 1937.—The 45th regular meeting was held February 9th, Mr. H. P. Newton presiding.

Mr. Paul Sykes was re-elected and Mr. O. McCutcheon was elected to membership.

The speaker for the evening was Dr. C. S. Beals of the Dominion Astrophysical Observatory at Victoria, his subject being "The End of the World". Dr. Beals approached his subject by pointing to the interest it has always held, as evidenced by legendary and historical references. Flood or fire were in most instances the expected means of destruction, though a Norse belief visualized

extreme cold. Predictions had been made from time to time for centuries by individuals who sometimes attracted a considerable following, the last notable example being in 1908.

Scientific examination reveals various possibilities that might make the earth uninhabitable by life as we know it. These include, loss of atmosphere, or change in its composition, change of earth's orbit, loss of mass and cooling of the sun, or a "nova" outburst of the sun.

It was shown that loss of atmosphere was unlikely under such conditions as we can foresee the velocity of escape from earth's gravitational field being 11 km/sec., while gaseous molecular velocities are found about $\frac{1}{2}$ km/sec. in the atmosphere. Oxygen is likely to form a sufficient proportion of our air to support life indefinitely.

The stability of the earth's orbit would be disturbed by the approach of a star to the solar system, but the distribution and motions of the stars are such that such approaches occur only at vast intervals of time. Planetary perturbations cumulative over very long periods may increase the ellipticity of the earth's orbit, with the result that drastic climatic changes would destroy life. Tidal friction will slow the earth's rotation until one day equals 47 as we know them, causing great extremes of heat and cold. In these cases the time-scale involved is very great, the lengthening of the day being of the order of 1/1000th of a second per century.

Loss of mass and cooling by the sun would seem inevitable since the energy radiated is believed to be derived from matter. It is estimated that loss of mass is 4 million tons per second, yet it is believed little change has taken place. The rate of radiation during the existence of the planetary system and calculations support the belief that no serious change is likely to occur over a similar period in the future.

If the sun were suddenly to become a "nova" or so-called new star, life on earth and probably the planet itself would be quickly destroyed, since the increase in radiation of novae in periods of only a few days, is of the order of 10,000 times. It was pointed out that novae most often develop from dwarf stars and that the sun is a dwarf, but whether the sun is of the "nova" type of dwarf is not known.

Of the predictable ends of the world, the times involved are very great, some 10^{12} to 10^{14} years.

Dr. Beals closed his address with a few thought-provoking speculations on the direction of human activities and progress during the ages that appear to be before us. A vote of thanks was accorded Dr. Beals and the meeting adjourned.

J. TEASDALE, *Secretary.*

The Royal Astronomical Society of Canada

OFFICERS FOR 1937

Honorary President—THE HON. LEONARD J. SIMPSON, M.D., Minister of Education for the Province of Ontario.
President—R. E. DELURY, M.A., PH.D., Ottawa.
First Vice-President—WM. FINDLAY, PH.D., Hamilton, Ont.
Second Vice-President—J. A. PEARCE, M.A., PH.D., Victoria.
General Secretary—E. J. A. KENNEDY, 198 College St., Toronto.
General Treasurer—J. H. HORNING, M.A., Toronto.
Recorder—R. H. COMBS, Toronto.
Librarian—P. M. MILLMAN, PH.D., Toronto.
Curator—R. S. DUNCAN, Toronto.
Council—D. S. AINSLIE, M.A., PH.D., Toronto; S. C. BROWN, Toronto; F. NAPIER DENISON, Victoria, B.C.; MISS A. VIBERT DOUGLAS, PH.D., Montreal; E. A. HODGSON, M.A., PH. D., Ottawa; DR. G. R. MAGEE, London, Ont.; J. E. MAYBEE, Toronto; A. THOMSON, M.A., Toronto; L. A. H. WARREN, M.A., PH.D., Winnipeg.

TORONTO CENTRE

Honorary Chairman—DR. C. A. CHANT
Chairman—E. J. A. KENNEDY — *Vice-Chairman*—S. C. BROWN
Secretary—F. L. HARVEY, 80 Gates Ave. — *Recorder*—MISS F. S. PATTERSON
Treasurer—J. E. MAYBEE — *Curator*—R. S. DUNCAN
Council—DR. D. S. AINSLIE; DR. L. GILCHSIRT; DR. F. S. HOGG; J. H. HORNING; T. H. MASON; DR. P. M. MILLMAN; REV. C. H. SHORTT; DR. R. K. YOUNG; and past Chairmen—A. F. Miller; A. F. Hunter; J. R. Collins; and A. R. Hassard

OTTAWA CENTRE

Honorary President—A. H. MILLER, M.A. — *President*—JOHN MCLEISH, B.A.
First Vice-President—MISS MIRIAM S. BURLAND
Second Vice-President—FRANCIS WM. MATLEY — *Secretary*—MALCOLM M. THOMSON, B.A.
Council—MISS PEGGY WHITEHURST; KARL BUCKTHOUGHT; A. H. SWINBURN; W. W. NICHOL, B.A.; T. L. TANTON, PH.D.; and past presidents, R. Glenn Madill, B.A.; J. S. Lane, B.A., and C. C. Smith, B.A.

MONTREAL CENTRE

Honorary President—MGR. C. P. CHOQUETTE — *President*—HENRY F. HALL
First Vice-President—DR. JULIAN C. SMITH — *Second Vice-President*—DR. F. D. KINDER
Secretary-Treasurer—DR. A. VIBERT DOUGLAS, McGill University
Council—DR. A. N. SHAW; GEO. H. LIGHTHALL; G. HARPER HALL; DR. L. V. KING; COL. W. E. LYMAN; O. A. FERRIER; E. RUSSELL PATERSON; J. ADDISON REID; DR. C. C. BIRCHARD

LONDON CENTRE

Honorary President—DR. H. R. KINGSTON
President—J. C. HIGGENS — *Vice-President*—D. M. HENNIGAR
Secretary—DR. G. R. MAGEE, 427 William St. — *Treasurer*—MRS. ALICE DAVIES
Council—MISS N. MORRIS; MISS S. LIVINGSTONE; T. C. BENSON; W. L. SCANDRETT; REV. H. E. FOUCAR; and Past President, Major E. H. Anundson

WINNIPEG CENTRE

Honorary President—DR. J. S. PLASKETT
President—W. H. DARRACOTT — *Vice-President*—J. H. KOLB
Secretary—G. P. MORSE, 3rd floor, Customs Building — *Treasurer*—R. D. COLQUETT
Council—M. F. BENNETT; L. T. S. NORRIS-ELYE; W. R. JUNKIN; H. P. STOKES; MRS. A. S. WILLIS; and Past President A. V. Piggott

VICTORIA CENTRE

Honorary President—H. BOYD BRYDON
President—GORDON SHAW — *Vice-President*—ROBERT PETERS
Secretary-Treasurer—R. M. PETRIE, PH.D. — *Librarian*—MISS MIRA OLIPHANT
Council—W. R. HOBDAY; L. HOPKINS; A. MCKELLER, PH.D.; W. PETRIE; MISS P. RIDDLE; K. O. WRIGHT, M.A.

HAMILTON CENTRE

Honorary President—MRS. D. B. MARSH — *President*—PROF. A. E. JOHNS
Vice-President—T. H. WINGHAM — *Second Vice-President*—GEO. CAMPBELL
Third Vice-President—W. T. GODDARD — *Curator*—T. H. WINGHAM
Secretary-Treasurer—N. H. BROADHEAD, 15 Mapleside Avenue
Council—E. E. BOSSENCE; G. FREEMAN; DR. W. FINDLAY; H. FOX; J. A. MARSH; W. S. MALLORY; REV. E. F. MAINSELL; MRS. S. W. SCAMMELL; J. S. TAYLOR

VANCOUVER CENTRE

Honorary President—DEAN D. BUCHANAN — *President*—H. P. NEWTON
First Vice-President—MRS. LAURA ANDERSON — *Second Vice-President*—SETO MORE
Secretary—J. TEASDALE, 4618 12th Avenue West — *Treasurer*—A. OUTRAM
Council—H. E. ACTON; G. E. FROSTRUP; H. W. FOWLER; J. C. JORGENSEN; M. A. MCGRATH; J. W. MOORE; D. L. SHAW; F. R. STEWART; E. C. THRUPP

EDMONTON CENTRE

Honorary President—J. W. CAMPBELL, M.A., PH.D.
President—J. G. TAYLOR — *Vice-President*—C. G. WATES
Secretary—PROF. E. S. KEEPING, University of Alberta — *Treasurer*—E. N. HIGINBOTHAM
Council—MISS M. O. BUCHANAN; MRS. E. R. CLINDININ; J. A. MCLEAN; DR. J. R. TUCK; F. S. SIMPSON

CALGARY CENTRE

President—HAROLD C. KING — *Vice-President*—H. J. REES
Secretary-Treasurer—G. FINLAY MOORE, 3206 Vercheres St.

THE ROYAL ASTRONOMICAL SOCIETY OF CANADA

This Society was incorporated in 1890 under the name of The Astronomical and Physical Society of Toronto, and assumed its present name in 1903.

The Society has active Centres in Montreal, P.Q.; Ottawa, Toronto, Hamilton, and London, Ont.; Winnipeg, Man.; Edmonton, Alta.; Vancouver and Victoria, B.C.

The Society publishes a monthly JOURNAL containing each year about 500 pages and a yearly OBSERVER'S HANDBOOK of about 80 pages. Single copies of JOURNAL or HANDBOOK are 25 cents.

Membership is open to anyone interested in astronomy. Annual dues, $2.00; life membership, $25.00. Publications are free to members, or may be subscribed for separately. Apply to the General Secretary, 198 College St., Toronto, or to the local secretary of a Centre.

Extract from the By-Laws: Candidates who are elected to membership will be attached to a particular Centre, or to a section known as *Members at Large*. Members of the Society who live outside of Canada, or in a province in which there is no Centre of the Society will be considered *Members at Large* and not attached to any particular Centre, unless these members are expressly nominated for membership and attachment to a particular Centre. Members may be transferred from one Centre to another, or to the section *Members at Large* by the Council of the Society if written application for such transfer is made by such member to the Council.

The Physical State of the Upper Atmosphere, by B. Haurwitz.

Reprinted from the JOURNAL of the Royal Astronomical Society, 1936-1937.

Pages 96; Price 50 cents postpaid.

The Society has for Sale:

General Index to the TRANSACTIONS of the R.A.S.C., 1890-1905, and the JOURNAL, Vols. 1 to 25, 1907-31.

Compiled by W. E. Harper, Assistant Director, Dominion Astrophysical Observatory, Victoria, B.C.

Pages, 122; Price, $1.00, postage 5c. extra.

Send Money Order to 198 College St., Toronto.